CLAIMS

What is claimed is:

1. A method for joining process quality control comprising:

providing at least one sensor having a meandering drive winding with at least three extended portions and at least one sensing element placed between an adjacent pair of extended portions;

passing a time varying electric current through the extended portions to form a magnetic field;

placing the sensor in proximity to the test material;

measuring an electrical property of the test material with the sensor and test material in relative motion, and

using a feature of the electrical property measurement in the control of the joining process.

2. The method as claimed in claim 1 wherein the joining process involves tracking the seam between the joint materials.

3. The method as claimed in claim 2 wherein the orientation of the extended portions is varied with respect to the seam axis.

4. The method as claimed in claim 1 wherein the electrical property is an electrical conductivity.

5. The method as claimed in claim 1 wherein the joining process is a friction stir welding process.

6. The method as claimed in claim 5 further comprising mounting at least one sensor in the anvil.

7. The method as claimed in claim 5 further comprising positioning a sensor ahead of the anvil and a sensor behind the anvil.

8. The method as claimed in claim 5 further comprising positioning a sensor ahead of the welding tool and a sensor behind the welding tool.

9. The method as claimed in claim 1 wherein the joining process uses a tool and the position of the sensor relative to the position of the tool is kept constant.

10. The method as claimed in claim 9 further comprising positioning a sensor over the front surface of the test material.

11. The method as claimed in claim 10 further comprising positioning another sensor near the back surface of the test material.

12. The method as claimed in claim 9 further comprising positioning a sensor ahead of the welding tool and a sensor behind the welding tool.

13. The method as claimed in claim 9 further comprising positioning a sensor over the front surface of the test material and a sensor near the back surface of the test material.

14. The method as claimed in claim 1 wherein the at least one sensor is not in contact with the test material.

15. The method as claimed in claim 1 further comprising the use of multiple excitation frequencies.

16. The method as claimed in claim 15 wherein the excitation frequency ranges from 100 Hz to 10 MHz.

17. The method as claimed in claim 1 wherein the sensing elements are inductive coils.

18. The method as claimed in claim 17 wherein the inductive coils form rows that are oriented parallel to the extended portions.

19. The method as claimed in claim 1 wherein the sensing elements are magnetoresistive sensors.

20. The method as claimed in claim 19 wherein the magnetoresistive sensors are giant magnetoresistive sensors.

21. The method as claimed in claim 1 wherein the sensing elements form an array for creating property images.

22. The method as claimed in claim 21 wherein the excitation frequency ranges is high to image surface breaking flaws.

23. The method as claimed in claim 22 wherein the excitation frequency ranges from 100 kHz to 10 MHz.

24. The method as claimed in claim 21 wherein the electrical property is magnetic permeability.

25. The method as claimed in claim 24 wherein the image provides a stress mapping of the heat affected zone and weld region.